Until very recent years, the history of medieval science has been regarded with mingled feelings, whether of indifference or aversion, due to the fact that real knowledge of the subject, as based upon the elliptical data in the printed literature, is so meager as to be deceptive, while what little is known has been constantly misread, over-stated or misinterpreted, according to the religious bias of the expositors. Until Sudhoff began to photograph and interpret the hitherto undiscovered medical manuscripts on the continent of Europe, such valuable source-books of medieval folk-medicine as Oswald Cockayne's "Leechdoms, Wortcunning and Starcraft of Early England" (1864–6) remained undisturbed on the dustier shelves of libraries. But with the foundation of the Leipzig Institute (1905), things began to take a new turn. The classified hand-list of manuscripts which Dr. and Mrs. Singer are making is an important move in aid of the problem: "How are we to trace the disintegration of Greek science in the Middle Ages and the slow processes which led to the apparently sudden rise of the experimental method?" Before we can investigate the great mass of undigested manuscript material, we must first have a reasoned catalogue; while to catalogue all the manuscripts in a single country is the first step to a classified "world catalogue" of such manuscripts. Encouraged by grants from the Royal Society and the British Academy, the Singer catalogue has already progressed far enough to enable its compilers to block out their classification by subjects. This list of subjects, replete with such rubrics as Aristotle, Menology, Bestiaries, Magic, Cosmology, Herbaria, Lapidaries, Marvels, Melothesia Physiognomy, Cheiromancy, etc., already affords a glimpse into the medieval mind; and could we conceive of a medieval scientific library, public or private, as attaining to any great size (impossible by reason of the costliness of the illuminated manuscripts and printed incunabula), we should have an inkling of the probable arrangement of its books, by alcoves and shelves. Some 15,000 of these manuscripts are medical, and, of these, 1,900 are on general medicine, 953 alchemical, 600 magical, 194 surgical, 178 gynecological, 72 pediatric, 144 veterinary, 274 on pulse-lore, 274 on uroscopy, 234 on blood-letting, 144 on diet, 18 on fevers, 90 on the pest, 63 on the eye, 600 on herbs and simples, 114 on physiognomy and cheiromancy, 106 on generation, while no less than 669 are bestiaries and 2,500 collections of recipes. These figures at once give a better notion of the extent to which medicine was followed in the Middle Ages, than any existing lists of medical incunabula. Most of these manuscripts were written between 1200 and 1500 A.D., and but few before the eighth century. Mrs. Singer shows by curve-tracing their distribution in time, the curve taking an abrupt and constantly upward slope after the thirteenth century. The second paper (1920) concludes with a highly instructive set of 34 legends for lantern slides of specimen pages.

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SPECIAL ARTICLES

THE ARRANGEMENT OF ATOMS IN SOME COMMON METALS

DURING the past year the crystal structures of several elementary substances have been determined. A brief summary of the results will be given here. Complete data will be published in the *Physical Review.*

The method is the same as that previously used.[1] A narrow beam of monochromatic X-rays is passed through the powdered material to be analyzed and produces on a photographic plate a pattern of fine lines. These lines are due to the reflection of the X-rays from the faces of the tiny crystals, one line for each kind of face. From the positions and intensities of the lines the crystal structure can be calculated.

CALCIUM

Calcium has generally been considered hexagonal, partly from analogy with magnesium

[1] *Phys. Rev.*, 10, 661, 1917; *Proc. A. I. E. E.*, 38, 1171, 1919. See also Debye & Sherrer, *Phys. Z.*, 18, 291, 483, 1917.

and zinc, and partly from a statement of Moissan[2] that it grows in hexagonal plates and rhombohedra.

The X-ray analysis shows it to be a perfect *face-centered cubic* arrangement of atoms, the side of the elementary cube being 5.56 Å. Each Ca atom is surrounded by 12 equidistant nearest neighbors, at distances of 3.93 Å.

TITANIUM

There is no crystallographic data regarding titanium. The X-ray analysis shows it to be a *centered cubic* arrangement, like chromium and iron. The side of the elementary cube is 3.144 Å. Each atom is surrounded by eight others, at distances of 2.72 Å.

ZINC

The arrangement of atoms in zinc is like that in magnesium, namely: *hexagonal close packed* (one of the two alternative arrangements that solid spheres assume when packed as closely as possible) except that it is elongated 14 per cent. in the direction of the hexagonal axis. The arrangement is that of *solid prolate spheroids in closest possible packing.*

Each atom is surrounded by six nearest neighbors, in its own plane, at distances of 2.67 Å, and by six others, three above and three below, at distances of 2.92 Å.

The observed axial ratio, 1.86, bears no simple relation to the value 1.356 found by crystallographers. The data on which the latter is based are, however, very unsatisfactory.

CADMIUM

The structure of cadmium is like that of zinc, namely: a *close packed arrangement of prolate spheroids*. The elongation of the spheroids is slightly greater than for zinc, viz., 16 per cent., corresponding to an axial ratio (ratio of altitude to side of elementary hexagonal prism) of 1.89.

Each atom has six nearest neighbors in its own plane at distances of 2.98 Å., and six others almost as near, three above and three below, at distances of 3.30 Å.

As in the case of zinc the observed axial ratio, 1.89, bears no obvious relation to the crystallographer's value, 1.335.

INDIUM

The atoms of indium are arranged in a *face-centered tetragonal lattice.* The axial ratio, that is, the ratio of altitude to base of the elementary tetragonal prism, is 1.06. The lattice is therefore like "cubic close packing" except that it is elongated 6 per cent. in the direction of one of the cubic axes. *It is a close-packed arrangement for prolate spheroids,* alternative with the zinc and cadmium type.

The side of the elementary prism is 4.58 Å., and its height 4.86 Å. Each indium atom has four nearest neighbors at distances of 3.24 Å., and eight others, four above and four below, at distances of 3.33 Å.

The crystallographic data assigned indium to the cubic system.

RUTHENIUM

The arrangement of atoms in ruthenium, like that in zinc and cadmium, is very close to *hexagonal close packing.* In this case, however, the lattice is *shortened* in the direction of the hexagonal axis by 3 per cent., giving an axial ratio of 1.59. *This is a close-packed arrangement for oblate spheroids.*

Each ruthenium atom is surrounded by six, in its own plane, at distance of 2,686Å., and by six others, three above and three below, at distances of 2.640 Å.

PALLADIUM

The atoms of palladium are in *face-centered cubic* arrangement. This is the "cubic close packed" arrangement for perfect spheres.

The side of the elementary cube is 3.92 Å. Each atom is surrounded by twelve equidistant neighbors at distances of 2.77 Å.

TANTALUM

The atoms of tantalum are in *centered cubic* arrangement, like tungsten. The side of the elementary cube is 3.272 Å. Each atom is surrounded by eight nearest neighbors at distances of 2.83 Å.

[2] See Groth, Chemische Krystallographie.

IRIDIUM

The atoms of iridium, like platinum, are in *face-centered cubic* arrangement.

The side of the elementary cube is 3.80 Å., and the distance from one atom to each of its twelve nearest neighbors 2.69 Å.

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EFFECTS PRODUCED BY X-RAY ENERGY ACTING UPON FROGS' OVA IN EARLY DEVELOPMENTAL STAGES

SEVERAL interesting and possibly significant facts were ascertained, in connection with the general study of the action of X-ray energy upon the fertilized frogs' ovum, through raying the entire egg at different developmental stages up to the time of closure of the neural tube. Because of the chemical and physical ontogenetic processes involving both proanlagen constituents, enzyme and nutritive, and immediately anticipating the morphologic features of differentiation, it was supposed that these substances must show a variable degree of absorption of energy dependent upon the stage of development. When the quantity of energy utilized remained constant, the defects produced should vary with the stage rayed. One might anticipate both gross and microscopic morphologic variations in the developed embryos. The results of this experiment, however, are precisely of the reverse nature.

The eggs were permitted to develop in the ponds where they were laid until the proper stage of development had been reached, whereupon they were brought immediately into the laboratory and rayed. Development was permitted to progress in glass jars of a capacity of 1,000 c.c., the water being changed frequently. Of the 300 eggs used for the experiment, upwards of fifty were sectioned serially. The embryos were fixed in formalin after Schultze's method at varying intervals after raying. None, however, was permitted to develop to the time of metamorphosis. In all of the experiments the distance from the target to the eggs and the per-second energy output of the tube were constant as was also the time of exposure. The tube carried a current strength of 50 milliamperes at 50 K.V. A dosage of 100 mam. was given to each group of from twenty to twenty-five eggs. These were placed 17.5 cm. from the target. The different groups represented approximately every developmental stage from the two-cell to the period of the closure of the neural tube. No attempt was made to orient the eggs with reference to the tube so that the animal pole or the vegetable pole or right side or left side of the embryos should be uppermost.

Contrary to what one might at first anticipate, the developed embryos were identical in every gross and microscopic detail to those produced by raying the whole ovum at the two-cell stage as described by the author in the *Anatomical Record* of November, 1919. This uniformity of results, irrespective of the stage rayed, is the most striking feature of the experiment. Sections of these embryos resemble in every histological detail those produced by the former method, and could serve very well to illustrate the results of that investigation. Since the author has already given these details, it would be superfluous to duplicate that description in this paper. The experiment represents, therefore, still another method by means of which a standardized, defective, morphologic condition may be produced.

Owing chiefly to our present lack of knowledge of the association of chemical formula with morphologic structure in the ovum, a completely satisfactory explanation of this phenomenon can not be given. Before such may be attempted, prolonged experimentation along this line must necessarily be carried out. This represents merely one step in the experimental analysis of the ovum and whatever conclusions are drawn from the phenomenon produced must be based very largely upon hypothesis.

The factors concerned fall into two natural categories, one embryological and the other chemical or physical, *i. e.*, one dealing with the embryological mechanism affected, and the other with the nature of the change produced in the physical and chemical constitution of the ovum. Granting the presence of a series of chemical ontogenetic modifications preceding